Growth of *Faidherbia albida* in Nurseries: Standard Production Techniques or Air Pruning?

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Abstract

Root coiling in the nursery is a problem with Faidherbia albida. *The standard practice is to cut off the root coil at the bottom of the pot before outplanting, but this can hinder plant development. Root coiling and/or roots growing out of the bottoms of the pots occurs in the nursery as early as 18 days after sowing and requires pruning of or pot transfer.*

Three nursery methods were studied—standard polyethylene pots with and without coil pruning, and rigid tubes that allowed air pruning of roots. Air-pruned plants were generally less developed than potted seedlings. However, they had 50% more secondary roots and 28% more nodules than potted plants with pruned root coils, and suffered less transplant shock.

After outplanting, there was no difference in plant development with the three treatments. Coil-pruned potted plants developed a new, effective taproot at the site of the pruning wound. Air-pruned tubed seedlings developed taproots from lateral roots. More work should be done with this method. Also, this study should be repeated in a more drought-stressed environment.

Introduction

Nursery production techniques for *Faidherbia albida* have yet to be optimized. Cazet (1987) demonstrated that root systems of *F. albida* grown in pots are inferior to those of direct seeded plants 6 months after sowing. Under 334 mm of rainfall, direct seeded plants had 14 times more root biomass than those of potted plants which had also stayed for 6 months in the field after 3 months in the nursery. Individuals established by direct seeding had large-diameter taproots whereas potted seedlings had taproots less than 1 cm in diameter.

The difference was explained by root pruning of potted seedlings at the time of outplanting. After 3 months in the nursery, *F. albida* seedlings form a coiled root at the bottom of the pot which can limit root development of outplanted seedlings. In Cazet's study (1987), development of new roots following pruning of the coiled taproot was poor. Reduced uptake of water and nutrients resulted in marked growth differences between the two treatments after 2 years.

Two trials were carried out to determine if production time in the nursery could be reduced in order to avoid formation of coiled roots, and if sufficiently well-formed seedlings could be obtained through air-pruning techniques.

Production Time in the Nursery

The first trial was done in the nursery to study growth of *F. albida* seedlings raised in perforated plastic pots 16 cm high and 9 cm in diameter. Results demonstrated that 20-cm tall seedlings suitable for planting could be produced in the nursey in less than 2 months. Seedlings were naturally inoculated and the nodules were active. It appears to be unnecessary and perhaps undesirable to keep the plants longer in the nursery for two reasons. Firstly, our results showed that young root-pruned *F. albida* seedlings regenerate their taproots better than older root-pruned seedlings. Secondly, frequent and numerous measurements of root systems showed that after day 52, fine roots on

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the upper part of taproots appeared to decrease in number to the point where their activity no longer seemed functional. Nodules in this root zone declined at the same time, and by day 60 had blackened. These superficial fine roots and nodules survive for a shorter period than previously thought.

Nursery Production Techniques

Although direct seeding of *F. albida* can result in higher quality seedlings than standard nursery techniques (Cazet 1987), climatic hazards limit the success of this method. For this reason, production of *F. albida* in the nursery remains necessary to ensure high rates of survival in the field.

Growth of *F. albida* in the nursery is very rapid and, ideally, seedlings can be outplanted after 2 months. However, due to many constraints, planting operations are often delayed and time in the nursery must be extended. In order to maintain superior root structure, pots must be shifted frequently, sometimes every 15 days in the later stages of nursery operations. This, however, is labor-intensive and expensive. Ways to limit the number of shiftings should be studied.

It was necessary to find out whether air pruning, which is increasingly being used in industrial nurseries, could be applied to *F. albida*. A trial was run to determine whether this technique results in well-formed *F. albida* seedlings which successfully redevelop taproots after planting.

Materials and Methods

Nursery Techniques

Two treatments were used, the first was raising seedlings in 9 × 16 cm polyethylene pots. Root pruning was done every 15 days in accordance with standard nursery practices. For the second treatment, seedlings were produced in bottomless tubes of uniform dimension which were placed on medium-size wire mesh suspended 30 cm above the ground. Root apices emerging from the base of the tube were exposed to air and died back, thus resulting in limited root elongation.

The trial consisted of 4 replications and 25 pots or tubes per plot. Two scarified seeds per tube or pot were sown on 20 Jul 1990.

Since the only available balance measured to the nearest 0.1 g, biomass measurements were feasible only after several months of growth. In month 7, 16 plants per treatment were randomly selected from the 4 replications and were destroyed for analyses. The potting medium was removed by a fine water jet, and the roots and nodules were carefully removed with tweezers. In the laboratory, a final cleaning preceded nodule counts and weighings. Because of the lack of accurate equipment, only fresh and dry weights (after 24 hours at 100°C) were measured. Nodule weights were too small to be accurately recorded.

Field Techniques

At month 4, a sub-trial was installed to study the impact of plant production techniques in the nursery on growth in plantations. Seedlings were planted in an 80-cm deep tub filled with sand to facilitate later destructive sampling. To simulate real plantation conditions, seedlings were watered on a weekly basis corresponding to 60 mm of rainfall per week. In 3 months, the plants received 780 mm, which represents Sudano-Guinean conditions. The trial was laid out in blocks of 4 repetitions, similar to the first trial. Five containers per treatment were planted. Because there was no thinning of the pots, this resulted in a range of 32-40 plants per treatment. Three planting methods were used: (1) potted seedlings planted after removing the plastic bag; (2) potted seedlings planted after cutting the base of the pot 2 cm from the bottom to eliminate the coiled roots; and (3) tubed seedlings planted by removing the plastic without disturbing the roots.

Results

Growth in the Nursery

At month 4, tubed plants averaged 23 cm in total height whereas potted plants averaged 27.8 cm. At month 7, the average above-ground biomass of tubed seedlings was 1.86 g; potted seedlings weighed 2.85 g on the average. Although these differences were not significant, the respective values were logical. After the two root prunings, potted plants developed temporary root systems that filled the available growing space and enhanced access to soil nutrients to an appreciable degree. Root pruning, although done frequently in the nursery, did not hinder initial plant development in the field.

When one potted and one tubed seedling were destroyed for measurement at the outplanting stage, it was noted that the potted plant formed a coil which represented more than 50% of the root system (dry

weight). It should be noted that 15% of seedlings had rooted through the drainage hole of the pot and therefore formed no coil. Taproots of the air-pruned seedlings stopped at the base of the tube. There was no taproot malformation, but some fine roots did develop in a circular pattern along the insides of the tube.

A difference in the spatial distribution of secondary roots was noted. For the air pruned, tubed seedlings, roots were homogeneously distributed throughout the tube. In the pots, however, they were concentrated at the base.

On the whole, plants raised in tubes were less developed compared with the potted plants. However, potted seedlings lost 38% of their root systems when coiled roots were cut off. It is probable that we underestimated measurements of root systems in the root-pruned pots. In one plant, a part of the root system grew upwards from the base of the pot to the top and could not be distinguished from the coiled roots before or after trimming them for planting.

At the time of outplanting, tubed seedlings had 15% less dry root mass and 31% less taproot mass than potted plants. However, tubed seedlings had 51% more secondary and fine root mass and 28% more nodules than potted plants. This represents a decisive advantage over plants raised using classical nursery techniques. There were no significant differences in seedling development at the time of planting or 3 months later (Table 1). The only statistically significant differences existing between treatments were numbers of coiled roots observed after planting and angle of insertion of the new roots (Table 2).

Contrary to observations by Cazet (1987), normal regrowth of taproots was observed after they were trimmed from potted seedlings. This may be due to the absence of moisture constraints in this trial, as opposed to that carried out in Senegal where annual rainfall was 334 mm.

Some air-pruned seedlings produced new taproots from lateral roots while still in the tubes. These lateral roots sometimes coiled upward in the tube at later stages of development. This problem could be minimized by using wider tubes with vertical ridges along the inner walls to limit root coiling and result in a well-formed root system.

Table 1. Average heights (cm) of outplanted *Faidherbia albida* seedlings at 4 and 7 months, Korgoho, Côte d'Ivoire, 1990.

Production Technique	Height at Month 4 (Outplanting) (cm)	Height at Month 7 (3 Months in Field) (cm)
Air Pruning	22.9	39.5
Potted, Base Cut	29.0	44.8
Potted, Base Uncut	26.6	43.0

Table 2. Development characteristics of *Faidherbia albida* seedlings 3 months after planting. Korgoho, Côte d'Ivoire, 1990.

Seedling parameter	Air pruned	Potted pruned	Potted unpruned
Root collar diameter (mm)	3.7	3.7	3.7
Diameter 10 cm below ground (mm)	5.1	5.2	5.0
Presence of root coils (%)	34	9	59[1]
Number of new taproots	1.5	1.7	2.0
Diameter of new taproots 10 cm below container (mm)	1.8	2.4	2.1
Insertion angle of new taproots (°)	102	135	107[1]
Dry shoot mass (g)	3.4	3.4	4.3
Root mass at planting (g)	2.1	2.1	2.7
Root mass 3 months after planting (g)	2.2	2.5	2.4

1. These were the only two parameters with significant differences between treatments ($P \leq 0.01$).

Conclusion

Air pruning of *F. albida* seedlings, induced by desiccation of root meristems emerging at the base of containers, was successfully achieved in the nursery. This is better than standard nursery techniques for three reasons. First, seedling root systems have more secondary and fine roots and nodules at the time of outplanting. Second, the root system remains undisturbed and is therefore fully functional after outplanting. Finally, this technique requires less labor both in the nursery and during outplanting. One disadvantage, however, was noted. Since root development was limited because of the small size of the tube, lateral roots coiled upwards. Use of larger tubes should be investigated.

Reference

Cazet, M. 1987. La régénération artificielle de *Faidherbia albida* en zone sahélienne. Plantation ou semis direct? Premiers résultats de l'expérimentation conduite à Thiénaba (Sénégal) en 1986. Dakar, Senegal: Direction des recherches sur les productions forestières. 49 pp. (Limited distribution.)

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Faidherbia albida

in the West African Semi-Arid Tropics

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Abstract

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This workshop brought together scientists and development workers, primarily those working in the West Africa region, to: review past and present research findings on *Faidherbia albida*; discuss development issues and "lessons learned" from past and present; list research priorities for the future; and promote collaboration between research and development programs.

These proceedings summarize the state of knowledge on the species and provide a comprehensive list of ongoing research. Papers are divided into sessions on: botany and distribution; uses; genetics, provenance trials, and vegetative propagation; site effects, silviculture, and rhizosphere; and development issues. Recommendations from Working Groups for future research and multidisciplinary linkages are included.

Résumé

Faidherbia albida *dans les zones tropicales semi-arides de l'Afrique occidentale—comptes rendus d'un atelier, 22–26 avril 1991, Niamey, Niger.* Cet atelier a regroupé des chercheurs et des coopérants, essentiellement ceux qui travaillent en Afrique de l'Ouest. Il a été destiné à: faire le point sur les résultats des recherches faites sur *Faidherbia albida* dans le passé et à présent; débattre des sujets concernant le développement et des 'leçons tirées' du passé et du présent; dresser la liste des priorités pour l'avenir; et promouvoir la collaboration entre les programmes de recherche et de développement.

Ces comptes rendus résument l'état actuel des connaissances sur les espèces et fournissent une liste complète des activités de recherche en cours. Les communications présentées sont divisées en sessions sur: botanie et distribution; utilisations; génétique, essais de provenance et multiplication végétative; impact du site, rhizosphère et sylviculture; et problèmes liés au développement. Les recommandations des Groupes de travail sur les recherches futures ainsi que sur les collaborations multidisciplinaires y sont également incluses.

Resumen

Faidherbia albida *en los trópicos semi-áridos de Africa occidental—actas del congreso, 22–26 Abril 1991, Niamey, Niger.* Este seminario reunió a científicos y trabajadores de desarrollo, especialemente a aquellos que trabajan en la región de Africa occidental, para: reseñar descubrimientos científcos pasados y presentes sobre la *Faidherbia albida*, discutir los aspectos de desarrollo y las 'lecciones aprendidas' del pasado y del presente, enumerar prioridades de investigación para el futuro y promover la colaboración entre los programas de investigación y desarrollo.

Estas actas resumen el nivel de conocimiento actual sobre la especie y proporciona una lista detallada de la investigación en marcha. Los papeles se dividen en sesiones sobre: botánica y distribución, usos, genética, ensayos de procedencia y propagación vegetative, influencias del entorno, silvicultura y rizosfera y aspectos de desarrollo. Se incluyen recomendaciones de grupos de trabajo para futuras investigaciones y conexiones multidisciplinarias.

Cover: *Faidherbia albida* growing in West Africa. [A computer-scanned negative of a photo by C. Barbier (CTFT 1988), used with permission of the Centre technique forestier tropical.]

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